

# **Workshop EJČF 2018**

Sunday 14 January 2018 - Saturday 20 January 2018

Bílý Potok (u Frýdlantu)

## **Book of Abstracts**



# Contents

Simulation of semiconductor pixel detector response 1 . . . . .	1
Luminozita na LHC 2 . . . . .	1
Dose distributions of different particles in a water phantom 3 . . . . .	1
TMD approach to the dipole model and the rcBK equation 4 . . . . .	1
$D^\pm$ measurement in Heavy-Ion Collisions at $\sqrt{s_{NN}} = 200$ GeV at the STAR experiment 5	2
Azimuthally sensitive femtoscopy with sorted events 6 . . . . .	2
Ultraperipheral collisions with ALICE 7 . . . . .	2
Výzkum vlivu teoretických neurčitostí na kinematiku jetové produkce 8 . . . . .	3
MAŠÍBL 9 . . . . .	3
Efekty studené jaderné hmoty 10 . . . . .	3
Study of the QGP medium with heavy quarkonia 11 . . . . .	4
Muon opposite side tagging in $B_s \rightarrow J/\psi + \phi$ 12 . . . . .	4
Charmed Mesons Production in Heavy Ion Collisions 13 . . . . .	4
Evolution of higher moments of multiplicity distribution 14 . . . . .	5
Experimental study of coincidence processes in microscopic quantum hardware generators of coincidence events 15 . . . . .	5
Studium zachycení Rydbergovských atomů a manipulace s nimi pomocí magnetických polí 16 . . . . .	5
Characterization of semiconductor detectors for space environment 17 . . . . .	6
Photoproduction of $J/\psi$ with ALICE 18 . . . . .	6
Connection between Energy Spectrum, Mass Composition and Distribution of Sources of Extragalactic Cosmic Rays 19 . . . . .	6
PPRA - Jiskrová komora 20 . . . . .	7
Coupling of $\Lambda$ to the Atomic Nucleus 24 . . . . .	7
Úvod do fyziky urychlovačů 25 . . . . .	7

Synchronizace laserových impulsů pro realizaci kolmého injektoru elektronového svazku do urychlovací fáze laserem řízené plazmové vlny 26 . . . . .	7
Studium produkce mezonů $D^\pm$ ve srážkách Au+Au při 200 GeV na experimentu STAR 27	8
Laser wakefield acceleration of electrons. 28 . . . . .	8
Search for BsPi 29 . . . . .	8
Coherent photoproduction of $\psi(2S)$ vector mesons in Pb–Pb UPC 30 . . . . .	9
Optimalizace rekonstrukce půvabných hadronů v srážkách d/p+Au 31 . . . . .	9
The Vector Boson Scattering in the ZZ Production at ATLAS 32 . . . . .	10
Impact of invisible energy on the energy reconstruction of cosmic ray shower at the Pierre Auger Observatory 33 . . . . .	10
Correlation femtoscopy 34 . . . . .	10
Efekty horké a studené jaderné hmoty ve srážkových experimentech 35 . . . . .	11
Praktické využití kvantového provázání 36 . . . . .	11
Multiplicity Fluctuations and Resonances in Heavy-Ion Collisions 37 . . . . .	11
ALICE AD detector 38 . . . . .	12
Numerical solutions to the Balitsky-Kovchegov evolution equation 39 . . . . .	12
Coherent $\rho^0$ photoproduction in heavy ion collisions 40 . . . . .	12
Timestamping optical photons using Timepix3 41 . . . . .	13
B-physics @ ATLAS 42 . . . . .	13
Measurements of $t\bar{t}$ differential cross-sections in the all-hadronic channel 43 . . . . .	13
Difrakce v částicové fyzice 44 . . . . .	14
$\Lambda_c$ baryon reconstruction and measurement of the $\bar{\Lambda}_c^- / \Lambda_c^+$ at the STAR detector in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV 45 . . . . .	14
Propagace a WWW 46 . . . . .	15
Measurement of inclusive pT spectra of jets in pp collisions at the ALICE experiment 47 .	15
The effects of QGP and CNM on heavy quarkonia production 48 . . . . .	15
Rydberg atoms in electric fields 49 . . . . .	15
Kde hledat příznaky nové fyziky, když je nevidí LHC? 50 . . . . .	16
Zahájení 51 . . . . .	16
How do quarks and gluons lose energy in the QGP? 52 . . . . .	16

**Studenti třetího ročníku / 1**

## Simulation of semiconductor pixel detector response

**Author:** Matěj Vaculčíak<sup>1</sup><sup>1</sup> CTU FNSPE**Corresponding Author:** vaculmat@fjfi.cvut.cz

In my thesis, I go in for a detector optimisation using mainly the Geant4 toolkit and Allpix-squared, a new Geant4-based program which is currently being developed in collaboration with CERN facility. In particular, I focus on radiation resistible semiconductor monolithic pixel detectors used in space dosimetry.

UPC / 2

## Luminozita na LHC

**Author:** Jan Půček<sup>1</sup><sup>1</sup> CTU FNSPE**Corresponding Author:** pucekjan@fjfi.cvut.cz

Luminozita je veličina, která udává poměr mezi frekvencí interakce a jejím účinným průřezem. Velkou výhodou luminozity je nezávislost na procesu. Ze znalosti luminozity a frekvence interakcí lze spočítat účinný průřez dané interakce. Na urychlovačích, používajících shluky částic ve svazku, je rozšířena metoda určení luminozity nesoucí název po fyziku Simonu van der Meeru. Pomocí této metody, která vyžaduje speciální nastavení urychlovače, je možné určit hodnotu absolutní luminozity a dále určovat pouze luminozitu relativní. K získání interpretovatelných výsledků je zapotřebí nejdříve analyzovat naměřená data, provést korekce a získat tzv. viditelný účinný průřez s jehož pomocí lze určit luminozitu v průběhu standardního nabírání dat. Nevýhodou této metody je požadavek faktorizovatelnosti shluku do dvou kolmých směrů. Tato prezentace předvede účinky nedodržení tohoto předpokladu.

**Studenti třetího ročníku / 3**

## Dose distributions of different particles in a water phantom

**Author:** Tadeáš Kmenta<sup>None</sup>**Corresponding Author:** kmenttad@fjfi.cvut.cz

Monte Carlo simulation using FLUKA code for dose distribution is presented and discussed. Dose distribution was scored in water phantom block produced by photon, electron, proton and carbon ion pencil beams for various energies using 1 million primary particles for 5 cycles. A comparison and analysis of particles contributing to the total dose deposited is given as well as the dose shapes.

UPC / 4

## TMD approach to the dipole model and the rcBK equation

**Author:** Marek Matas<sup>1</sup>

<sup>1</sup> *České vysoké učení technické v Praze*

**Corresponding Author:** matasma2@fjfi.cvut.cz

Using the rcBK evolution equation to calculate the scattering amplitude and from it, the Transverse Momentum Distribution functions can be very useful because of its use in calculation of factorised cross sections. In this contribution, we will address some key aspects of this topic as well as show, how such computation can be carried out.

**STAR - Heavy Flavour / 5**

## **$D^\pm$ measurement in Heavy-Ion Collisions at $\sqrt{s_{NN}} = 200$ GeV at the STAR experiment**

**Author:** Zuzana Moravcová<sup>1</sup>

<sup>1</sup> *CTU FNSPE*

**Corresponding Author:** zuzana.moravcova@fjfi.cvut.cz

Measurements of open heavy flavour mesons can be used to study the properties of the, so called, quark-gluon plasma produced in heavy-ion (A+A) collisions. The STAR collaboration searches for differences in particle production between the A+A and p+p collisions via the nuclear modification factor. In the low-pt region,  $D^\pm$  mesons cannot be directly reconstructed with traditional methods due to the high combinatorial background in A+A collisions. Therefore, machine learning methods in multivariate data analysis are used to discriminate between signal and background thanks to the TMVA package implemented within the ROOT framework.

**Teorie a fenomenologie / 6**

## **Azimuthally sensitive femtoscopy with sorted events**

**Author:** Jakub Cimerman<sup>1</sup>

<sup>1</sup> *České vysoké učení technické v Praze*

**Corresponding Author:** cimerjak@fjfi.cvut.cz

In the first part of the talk we shall investigate how the averaging over a large number of events influences the shape of the observed correlation function. We demonstrate that a shape characterised by Levy distribution may result from an average over Gaussian sources with varying sizes and orientations. We then propose to sort the events according to their similarity and investigate azimuthal dependence of the correlation radii on events classes which differ in shape. The method is explained and demonstrated on events simulated with different event generators.

**UPC / 7**

## **Ultraperipheral collisions with ALICE**

**Author:** Roman Lavička<sup>1</sup>

<sup>1</sup> CTU FNSPE

**Corresponding Author:** roman.lavicka@fjfi.cvut.cz

There are several different predictions for the behaviour of the gluon distribution in nuclei at small Bjorken  $x$  and experimental data is needed to choose among them. This is achieved by measuring the cross section of processes specially sensitive to this parton distribution. We focus on ultra-peripheral collision of lead-lead nuclei producing a  $J/\psi$  meson. Our main task is to calculate the rapidity- and  $t$ -dependence of the cross section. In this thesis we report our results with Run-1 data collected with an integrated luminosity of  $22.4_{-1.2}^{+0.9} \mu\text{b}^{-1}$ . The cross section dependence on rapidity is  $d\sigma_{J/\psi}^{\text{coh}}/dy = 0.98_{-0.06}^{+0.07}(\text{sta}) \text{ mb}$ . A detailed description of the measurement as well as the first results on low intensity data samples of Run-2 are available in the thesis. Descriptions of our work on UPC triggers and the luminosity calculation framework are parts of the thesis as well.

**Studium jetů / 8**

## Výzkum vlivu teoretických neurčitostí na kinematiku jetové produkce

**Author:** Vladimír Žitka<sup>1</sup>

<sup>1</sup> České vysoké učení technické v Praze

**Corresponding Author:** zitkavla@fjfi.cvut.cz

Ve své prezentaci se zmíním o vlivu hodnoty konstanty silné interakce na tvar spekter pozorovatelných veličin při studování vlastností protonových srážek, ve kterých se produkuje dva a více částicových spršek. Ukážu jak se tyto spektra pozorovatelných mění s hodnotou konstanty na příkladu simulovaných dat.

9

## MAŠÍBL

**Authors:** Miroslav Myška<sup>1</sup>; Jára Cimrman<sup>None</sup>

<sup>1</sup> CTU FNSPE

**Corresponding Author:** miroslav.myska@fjfi.cvut.cz

co se do dějin fyziky nevešlo aneb jediná srozumitelná prezentace :)

**Studenti třetího ročníku / 10**

## Efekty studené jaderné hmoty

**Author:** Jaroslav Štorek<sup>1</sup>

<sup>1</sup> CTU FNSPE

**Corresponding Author:** storejar@fjfi.cvut.cz

V příspěvku budou po krátkém úvodu standardního modelu vysvětleny všechny základní pojmy fyziky vysokých energií. Dále bude uvedena QGP a efekty stínění. Podrobněji budou rozebrány efekty produkce těžkých kvarků, především studené jaderné hmoty. Na závěr příspěvku budou shrnuty dosavadní výsledky na experimentech STAR, CMS a ALICE.

**Studenti třetího ročníku / 11**

## Study of the QGP medium with heavy quarkonia

**Author:** Martin Klíšťinec<sup>1</sup>

<sup>1</sup> CTU FNSPE

**Corresponding Author:** klistmar@fjfi.cvut.cz

In this thesis i am focusing on measuring the propheties of quark-gluon plasma via suppression of mezon  $\Upsilon$ . This thesis also contains information about basic propheties of quark-gluon plasma and effects that cause suppression or enhancement of mezon  $\Upsilon$ .

**ATLAS physics / 12**

## Muon opposite side tagging in $B_s \rightarrow J/\psi + \phi$

**Author:** Lukáš Novotný<sup>1</sup>

<sup>1</sup> CTU FNSPE

**Corresponding Author:** novotl23@fjfi.cvut.cz

Complex phase in the CKM matrix describing quark mixing causes CP violation and can be studied in the decay  $B_s^0 \rightarrow J/\psi + \phi$ . The determination of the initial flavour of neutral  $B$  mesons can be inferred using information from the  $B$  meson containing other pair-produced b-quark, referred as opposite-side tagging. To study and calibrate the opposite-side tagging method, decays  $B^\pm \rightarrow J/\psi + K^\pm$  are used. This presentation will talk about muon-based tagging.

**Obhajoby výzkumných úkolů / 13**

## Charmed Mesons Production in Heavy Ion Collisions

**Author:** Robert Líčeník<sup>1</sup>

<sup>1</sup> CTU FNSPE

**Corresponding Author:** robert.licenik@fjfi.cvut.cz

Charmed mesons serve as an excellent probe in the strongly interacting medium created during heavy ion collisions. This medium is called the quark-gluon plasma and it is an object of great interest due to its connection to the early stages of the Universe. The charmed mesons, such as the  $D^\pm$ , are created during the hard scattering part of the collision and therefore experience the entire evolution of the system. The results shown in this thesis, confirming the conclusions of earlier



measurements, were made possible using the newly installed Heavy Flavor Tracker at the STAR experiment. This detector enables unprecedented accuracy in the reconstruction of secondary vertices, that occur as a result of charmed meson decay into daughter particles. Precise reconstruction of secondary vertices allows for higher efficiency of the charmed meson yield measurements in heavy ion collisions.

**Teorie a fenomenologie / 14**

## Evolution of higher moments of multiplicity distribution

**Author:** Radka Sochorová<sup>1</sup>

<sup>1</sup> *CTU FNSPE*

**Corresponding Author:** sochorad@fjfi.cvut.cz

With the help of a master equation we study the evolution of the multiplicity distribution. Particularly we focus on the third and fourth factorial moments from which all other kinds of moments can be calculated. We first study how the third and the fourth moments thermalise when the kinetic temperature is fixed. Then we study the evolution of the moments in a situation with decreasing temperature. It is shown that the relaxation time is the same for all moments but moments of higher orders get initially further from the equilibrium value if temperature is changed.

**Studenti třetího ročníku / 15**

## Experimental study of coincidence processes in microscopic quantum hardware generators of coincidence events

**Author:** Tomáš Novák<sup>1</sup>

<sup>1</sup> *Bachelor student*

**Corresponding Author:** novakt36@fjfi.cvut.cz

Presenting microscopic quantum hardware generators of coincidence events. Generators evenly gathering data sets of measured coincident quantum based variable. Evolution of such variable is examined by the tools of the TISEAN software package exploiting the approach of non-linear times series analysis.

**Obhajoby výzkumných úkolů / 16**

## Studium zachycení Rydbergovských atomů a manipulace s nimi pomocí magnetických polí

**Author:** Alena Zemanová<sup>1</sup>

<sup>1</sup> *České vysoké učení technické v Praze*

**Corresponding Author:** zemanal5@fjfi.cvut.cz

Rydbergovské atomy jsou takové atomy, jejichž alespoň jeden elektron je excitován do vysokého kvantového stavu. Jejich doba života je extrémně dlouhá a vzhledem k tomu, že mají velký dipólový

moment, jsou extrémně citlivé na působení externího pole, což se využívá především při manipulaci v takových polích. Experiment AEGIS, jemuž se věnuje první část práce, se v současné době zabývá výrobou antivodíku pomocí nábojové výměny mezi antiprotony a Rydbergovským pozitroniem. Takto vzniklé antivodíkové atomy jsou taktéž Rydbergovské a studiem jejich pohybové rovnice a jejich manipulací v magnetických polích se zabývá druhá část práce.

Studenti třetího ročníku / 17

## Characterization of semiconductor detectors for space environment

**Author:** Anežka Kabátová<sup>1</sup>

<sup>1</sup> CTU FNSPE

**Corresponding Author:** kabatane@fffi.cvut.cz

The subject of my thesis is space radiation detection using semiconductor detectors. Firstly, simulation of detector response in Geant4 - Monte Carlo based software toolkit is involved. Later, test measurement is carried out on Tandatron accelerator in Řež.

UPC / 18

## Photoproduction of $J/\psi$ with ALICE

**Author:** Tomáš Herman<sup>1</sup>

<sup>1</sup> CTU FNSPE

**Corresponding Author:** hermato8@fffi.cvut.cz

The exclusive photoproduction of a  $J/\psi$  allows us to examine the transverse distribution of matter inside proton or nucleus targets. Moreover, this photoproduction is a great tool to explore the phenomenon of saturation and nuclear shadowing in the region of low  $x$ . From QED calculations and models describing the QCD part of the interaction it is possible to calculate the cross section for a given photoproduction process. By analysing ultra-peripheral collisions (Pb-Pb or p-Pb) with ALICE at the LHC we can measure experimental values for photoproduction cross sections and compare them with theoretical predictions, thus putting constraints on theoretical models.

Kosmické záření / 19

## Connection between Energy Spectrum, Mass Composition and Distribution of Sources of Extragalactic Cosmic Rays

**Author:** Alena Bakalová<sup>1</sup>

<sup>1</sup> CTU FNSPE

**Corresponding Author:** bakalale@fffi.cvut.cz

Cosmic ray particles undergo many changes during their propagation through the Universe including energy losses due to interactions with CMB or deflections in both galactic and extragalactic

magnetic fields. Such effects make it much more difficult to identify some general cosmic ray properties and their original source. Results concerning the slope of the end of the cosmic ray energy spectrum in dependence on the source distance and mass composition of the primary cosmic rays from MC simulations made in CRPropa will be introduced.

20

## PPRA - Jiskrová komora

**Author:** Jan Půček<sup>1</sup>

**Co-authors:** Lukáš Marek <sup>1</sup>; Ondřej Sedláček <sup>1</sup>; Pavel Gajdoš <sup>2</sup>; Tomáš Herman <sup>1</sup>; Valentina Raskina <sup>1</sup>; Veronika Agafonova <sup>2</sup>; Zuzana Moravcová <sup>1</sup>

<sup>1</sup> CTU FNSPE

<sup>2</sup> České vysoké učení technické v Praze

**Corresponding Author:** pucekjan@fjfi.cvut.cz

**Teorie a fenomenologie / 24**

## Coupling of $\Lambda$ to the Atomic Nucleus

**Author:** Jan Pokorný<sup>1</sup>

<sup>1</sup> CTU FNSPE

**Corresponding Author:** pokorj29@fjfi.cvut.cz

We discuss the coupling of the  $\Lambda$  particle to the atomic nucleus in the mean-field approximation. The mean field is constructed by the Hartree-Fock (HF) method. We develop a formalism of the HF method including the three-body NNN and  $\Lambda$ NN interactions. The HF basis is used as a starting point for the Tamm-Dancoff Approximation (TDA). We present a generalization of the TDA that couples  $\Lambda$  to nucleon - NA TDA.

**Detektory a urychlovače / 25**

## Úvod do fyziky urychlovačů

**Author:** Ondřej Sedláček<sup>1</sup>

<sup>1</sup> CTU FNSPE

**Corresponding Author:** sedlaon4@fjfi.cvut.cz

Vysokoenergetická fyzika potřebuje pro svá měření a výzkum co nejpřesněji definované vlastnosti srážejících se svazků, proto fyzika urychlovačů je esenciálním aspektem těchto experimentů. Porozumění základům fyziky a technologie svazku poskytuje základ pro oblasti teorie svazku či až inženýrské aplikace. K základům fyziky urychlovačů patří oblasti optické soustavy a příčné dynamice, které budou v této prezentaci uvedeny spolu s pojmem emitance.

**Detektory a urychlovače / 26****Synchronizace laserových impulsů pro realizaci kolmého injektoru elektronového svazku do urychlovací fáze laserem řízené plazmové vlny****Author:** Pavel Gajdoš<sup>1</sup><sup>1</sup> *České vysoké učení technické v Praze***Corresponding Author:** gajdopa1@fjfi.cvut.cz

Pro urychlení elektronů pomocí laserem řízené plazmové vlny je nutné zajistit jejich dostatečný počet v urychlovací fázi. K tomu lze využít několika metod. Jedna z možností je kolize dvou na sebe kolmých laserových impulsů. Hlavní svazek vytváří plazmovou vlnu a vedlejší, který je slabší, do ní injektuje elektrony. V této práci je uveden návrh optické soustavy určené pro přesnou synchronizaci těchto femtosekundových laserových impulsů.

**STAR - Heavy Flavour / 27****Studium produkce mezonů  $D^\pm$  ve srážkách Au+Au při 200 GeV na experimentu STAR****Author:** Jan Vaněk<sup>None</sup>**Corresponding Author:** jan.vanek@fjfi.cvut.cz

Měřením produkce mezonů  $D^\pm$  v ultra-relativistických jádro-jádrových srážkách se studují vlastnosti kvark-gluonového plazmatu (QGP). Půvabné kvarky v těchto mezonech totiž vznikají ještě před zažehnutím QGP v tzv. tvrdých procesech a musí tedy projít část objemu QGP, kde ztratí část své hybnosti a energie. Tyto ztráty lze kvantifikovat srovnáním produkce  $D^\pm$  v jádro-jádrových a proton-protonových srážkách pomocí jaderného modifikačního faktoru  $R_{AA}$ . Cílem této analýzy je určit  $R_{AA}$  pro  $D^\pm$  ve srážkách Au+Au při  $\sqrt{s_{NN}} = 200$  GeV měřených experimentem STAR v roce 2016. Prezentace shrnuje současný stav práce s důrazem na fyzikální motivaci.

**Studenti třetího ročníku / 28****Laser wakefield acceleration of electrons.****Author:** Ekaterina Eremenko<sup>1</sup><sup>1</sup> *CTU FNSPE***Corresponding Author:** eremeeka@fjfi.cvut.cz

Laser based acceleration technology allows to produce high electric fields with a centimeter-scale device. The basic physics of Laser Wakefield Acceleration is introduced. To get stable mono-energetic electron beam, particles should be firstly injected into the plasma wave. Different types of electron injection are reviewed. The experimental techniques for density measurement above the supersonic gas jet are presented.

**ATLAS physics / 29**

## Search for BsPi

**Author:** Radek Novotný<sup>1</sup>

<sup>1</sup> CTU FNSPE

**Corresponding Author:** radek.novotny2@fjfi.cvut.cz

Last year, the D0 experiment announced the observation of narrow structure X(5568) in decay of  $B_s + \pi$  with almost 5  $\sigma$  significance. This structure is investigated by the B-Physics Working group based on a data sample recorded with the ATLAS detector corresponding to 4.9  $\text{fb}^{-1}$  of pp collision data at 7 TeV and 19.5  $\text{fb}^{-1}$  at 8 TeV.

Obhajoby výzkumných úkolů / 30

## Coherent photoproduction of $\psi(2S)$ vector mesons in Pb–Pb UPC

**Author:** Zuzana Gajdošová<sup>1</sup>

<sup>1</sup> CTU FNSPE

**Corresponding Author:** gajdozuz@fjfi.cvut.cz

One of the open questions in QCD today is the cause of the shadowing phenomenon in nuclei. To understand this phenomenon it is necessary to study gluon distributions in nuclei at small  $x$ . There are several models trying to describe such phenomenon in QCD which have to be experimentally scrutinised and confirmed. One of the suitable processes to investigate gluon distributions in nuclei is the coherent photoproduction of a vector meson. The measurement of its cross section can serve as a verification of one or more theoretical predictions of this QCD phenomenon.

The tools for the calculation of the cross section of the coherent photoproduction of the vector meson  $\psi(2S)$  were prepared, such as determination of the yield of  $\psi(2S)$ , the calculation of luminosity, the determination of the product of the acceptance and efficiency and estimation of some related systematic uncertainties. The studies presented here were performed with data from Pb–Pb collisions at a centre-of-mass energy  $\sqrt{s_{NN}} = 5.02$  TeV collected during the Run 2 data-taking period at the LHC with the ALICE detector at mid-rapidity. The measurement of the cross section at this rapidity region and with almost 2 times higher energies than in Run 1 will provide an important contribution to the search for the origin of the shadowing.

Studenti třetího ročníku / 31

## Optimalizace rekonstrukce půvabných hadronů v srážkách d/p+Au

**Author:** Tomáš Truhlář<sup>1</sup>

<sup>1</sup> CTU FNSPE

**Corresponding Author:** truhltom@fjfi.cvut.cz

The subject of my thesis is optimization of charm hadrons reconstruction especially in d/p+Au collisions using multivariate data analysis.

The first part of my talk is about the The Toolkit for Multivariate Data Analysis with ROOT (TMVA) itself. Then its importance is demonstrated on some examples in HEP. And in the end, results gained by using TMVA are compared with results from classical analysis.

ATLAS physics / 32

## The Vector Boson Scattering in the ZZ Production at ATLAS

**Author:** Ondřej Penc<sup>1</sup><sup>1</sup> *České vysoké učení technické v Praze***Corresponding Author:** [ondrej.penc@fffi.cvut.cz](mailto:ondrej.penc@fffi.cvut.cz)

Evidence of the vector boson scattering (VBS) phenomena was discovered in Run 1 of the ATLAS detector at the LHC in the same sign WW production channel. Since the detector acquire more and more data in Run 2, the phenomena starts to be accessible also in the ZZ channel. This channel is very clean because of the small background other than coming from QCD and provides a good opportunity to enlarge the knowledge of such rare processes. The multivariate analysis (MVA) techniques are utilised to further extract the signal from QCD background. The analysis strategy is to measure the cross-section of the ZZ in the VBS-enhanced phase-space and then extract the electroweak VBS cross-section using the MVA techniques. The study is also challenging the setting of limits on anomalous quartic gauge coupling.

Kosmické záření / 33

## Impact of invisible energy on the energy reconstruction of cosmic ray shower at the Pierre Auger Observatory

**Author:** Šimon Novák<sup>None</sup>**Corresponding Author:** [novaksi1@fffi.cvut.cz](mailto:novaksi1@fffi.cvut.cz)

Ultra high-energy cosmic ray showers (UHERCs) are being detected at the Pierre Auger Observatory (PAO) in Argentina. Calorimetric energy measured by fluorescence detectors does not represent the total energy of a shower. The part of shower energy called missing energy is carried away undetected mainly by muons and neutrinos. Monte Carlo simulations of UHERCs in CONEX and Corsika programs with hadronic interaction models EPOS LHC and QGSJET-II-04 are used to estimate the shower missing energy and the results are compared. Possible missing energy estimation using signals from surface detectors at the PAO is also investigated.

Teorie a fenomenologie / 34

## Correlation femtoscopy

**Author:** Lukáš Holub<sup>1</sup><sup>1</sup> *CTU FNSPE***Corresponding Author:** [holubl11@fffi.cvut.cz](mailto:holubl11@fffi.cvut.cz)

In my presentation, I will present a preliminary analysis of correlation femtoscopy measurements of two positive and negative charged pions at small relative momenta, using STAR data from p–Au collisions at  $\sqrt{s_{NN}} = 200$  GeV. The correlation includes Bose-Einstein and Coulomb interaction. The strong interaction is not included here because it is not relevant. Obtained correlation functions are fitted by Gauss and Levy functions. These simple fits do not include an area of small relative momentum,  $q \sim 0.05$  GeV/c, because they are not able to describe

Coulomb interaction. Fits, which include Coulomb interaction at small relative momenta are also provided.

Studenti třetího ročníku / 35

## Efekty horké a studené jaderné hmoty ve srážkových experimentech

Author: Jakub Kubát<sup>1</sup>

<sup>1</sup> ČVUT FJFI

Corresponding Author: kubatja8@fffi.cvut.cz

Na urychlovačích LHC v ženevském CERNu a RHIC v americké BNL jsme dnes schopni dosahovat energií, které nám umožňují simulovat podmínky na úplném počátku vesmíru. V jádro-jaderných srážkách zkoumáme fázi hmoty, ve které se barevně nabitě kvarky a gluony pohybují v nevázaných stavech. Toto extrémně horké médium nazýváme kvark-gluonové plazma (QGP) a pomocí četných experimentálních metod určujeme jeho vlastnosti. Mezi jevy, které potvrzují přítomnost horké jaderné hmoty v jádro-jaderných srážkách, patří mimo jiné například potlačení produkce kvarkonií. Pro přesnou analýzu jevů způsobených efekty dekonfinované jaderné hmoty je třeba zkoumat i efekty studené jaderné hmoty na tyto procesy. Vlastnosti studené jaderné hmoty se pozorují ve srážkách hadron-jaderných. V příspěvku budou stručně shrnuty některé z efektů horké i studené jaderné hmoty a také připomenuty základní vlastnosti silné interakce umožňující vznik QGP.

Kvantová informace / 36

## Praktické využití kvantového provázání

Author: Elisabeth Andriantsarazo<sup>None</sup>

Corresponding Author: a.bety@seznam.cz

Kvantová fyzika rozšiřuje způsoby, jak lze manipulovat s informací. Jedna z vlastností, která nemá v klasické fyzice analogii, a kterou tudíž nelze při práci s informací v klasických systémech využít, je kvantové provázání. Tuto vlastnost lze chápat jako určitý druh korelace mezi komponentami fyzikálního systému. Míra této korelace však není v klasických fyzikálních systémech dosažitelná. Za komponenty takového provázaného systému lze brát kvantové bity, neboli qubity, které jsou v praxi realizovány libovolným dvouhladinovým systémem (polarizací fotonu, spinem elektronu), na rozdíl od bitu však mohou nabývat libovolné superpozice krajních stavů (tradičně označovaných jako 0 a 1).

Silné korelace, které z provázání vyplývají, jsou pak využity k vývoji nových technologií, například kvantových počítačů, v nichž jsou spolu qubity provázány a mohou tak mezi sebou komunikovat. Další využití nacházíme při vývoji bezpečnějších kryptografických protokolů v kvantové kryptografii.

Teorie a fenomenologie / 37

## Multiplicity Fluctuations and Resonances in Heavy-Ion Collisions

Author: Josef Uchytíl<sup>1</sup>

<sup>1</sup> CTU FNSPE

**Corresponding Author:** uchytojso@fjfi.cvut.cz

The number of particles produced in ultra-relativistic nucleus-nucleus collisions is well described by the statistical model. In this model, the particle yields depend on temperature and chemical potential. However, statistical physics can also predict multiplicity fluctuations, which can subsequently be compared to experimental data. Our primary aim research is to provide information on how to compute multiplicity fluctuations within the statistical model. In this talk, the grand canonical variance of the proton and baryon number multiplicity distribution in the Hadron Resonance Gas will be provided, along with the elaboration of the DRAGON programme, which we use to update the list of hadrons and resonance decays. Furthermore, a further outlook of my diploma thesis will be provided.

UPC / 38

## ALICE AD detector

**Author:** Michal Broz<sup>1</sup>

<sup>1</sup> České vysoké učení technické v Praze

**Corresponding Author:** michal.broz@fjfi.cvut.cz

A compact detector called AD was added to the ALICE apparatus at the beginning of the LHC run 2 in order to extend the trigger capabilities. In this talk we will concentrate on all kinds of boring details about calibration, data reconstruction and quality assurance in order to provide a picture of how a small part of modern high-energy experiment works in the real life.

UPC / 39

## Numerical solutions to the Balitsky-Kovchegov evolution equation

**Author:** Dagmar Bendová<sup>1</sup>

<sup>1</sup> CTU FNSPE

**Corresponding Author:** bendodag@fjfi.cvut.cz

The high energy limit of QCD can be studied using the Deep inelastic scattering (DIS) at small Bjorken- $x$ . Under these circumstances the gluon density rapidly increases. However the increase is eventually tamed by recombination, as the experimental data suggest us, which leads to the effect called parton saturation. To predict the cross-section of DIS we need to determine the cross-section of the dipole scattered off the hadron. Using numerical solution of the so called Balitsky-Kovchegov evolution equation we can obtain the dipole scattering amplitude, which depends on the above mentioned effects, and therefore predict the cross-sections of wide range of processes.

Studenti třetího ročníku / 40

## Coherent $\rho^0$ photoproduction in heavy ion collisions

**Author:** Gitika Bhalla<sup>1</sup>



<sup>1</sup> CTU FNSPE**Corresponding Author:** bhallgit@fjfi.cvut.cz

A summary of several papers on the coherent  $\rho^0$  photoproduction in ultra-peripheral heavy ion collisions and the comparison of their findings along with model comparisons. 4 papers by the STAR collaboration reporting on Au-Au collisions at  $\sqrt{S_{NN}} = 130$  GeV,  $\sqrt{S_{NN}} = 200$  GeV,  $\sqrt{S_{NN}} = 62.4$  GeV, and one by the ALICE collaboration reporting on Pb-Pb collisions at  $\sqrt{S_{NN}} = 2.76$  TeV all using the  $\pi^+\pi^-$  decay channel.

Detektory a urychlovače / 41

## Timestamping optical photons using Timepix3

**Author:** Peter Švihra<sup>1</sup><sup>1</sup> České vysoké učení technické v Praze**Corresponding Author:** peter.svihra@fjfi.cvut.cz

We describe here fast optical cameras based on a new silicon pixel sensor, which in combination with the Timepix chips, will provide nanosecond scale time resolution and high quantum efficiency for photons with wavelength between 400 and 1050nm.

ATLAS physics / 42

## B-physics @ ATLAS

**Author:** Tomáš Jakoubek<sup>1</sup><sup>1</sup> České vysoké učení technické v Praze**Corresponding Author:** tomas.jakoubek@fjfi.cvut.cz

The talk will give an overview of recent  $B$ -physics measurements at the ATLAS experiment, with a focus on the  $CP$  violation in  $B_s^0 \rightarrow J/\psi(\mu^+\mu^-)\phi(K^+K^-)$  decay channel. In the Standard Model  $CP$  violation is described by a phase in the CKM matrix. One of the manifestations of this complex phase is a phase shift between direct and mixing-mediated  $B_s$  decays producing a common final state. In the case of  $B_s^0 \rightarrow J/\psi(\mu^+\mu^-)\phi(K^+K^-)$  this phase shift is predicted to be small  $\phi_s = -0.0368 \pm 0.0018$  rad. New physics can enhance  $\phi_s$  whilst satisfying all existing constraints. Results presented in this talk are compatible with the Standard Model predictions and with other LHC measurements.

ATLAS physics / 43

## Measurements of $t\bar{t}$ differential cross-sections in the all-hadronic channel

**Author:** Ota Zaplatílek<sup>1</sup><sup>1</sup> CTU FNSPE

**Corresponding Author:** zaplaota@jfifi.cvut.cz

Currently large  $t\bar{t}$  production at the LHC allows detail study of the top quark,  $t\bar{t}$  quark pairs. The talk will introduce the results of the analysis interested with the measurement of differential cross-section of high boosted  $t$  quark and  $t\bar{t}$  pairs as a function of various kinematic observables. Study is performed on the full datasets collected by the ATLAS detector at  $\sqrt{s} = 13$  TeV and  $pp$  collisions in 2015 and 2016. The integrated luminosity of considered datasets reached up  $36.1 \text{ fb}^{-1}$ . The studied spectra were corrected for detector effects and devolved to particle and parton fiducial phase space. The comparison is done with several type of theoretical predictions primarily with Powheg+Pythia8 Monte-Carlo generator. Such study provides a unique opportunity to test of Standard Model at the TeV scale.

UPC / 44

## Difrakce v částicové fyzice

**Author:** David Horák<sup>1</sup>

<sup>1</sup> České vysoké učení technické v Praze

**Corresponding Author:** david.horak@jfifi.cvut.cz

Difrakční procesy se ukazují jako velmi velmi dobrá sonda do struktury protonu. Tyto procesy se v 60. letech pokoušela vysvětlit Reggeho teorie pomocí výměny tzv. pomeronu, a to velmi úspěšně. V této přednášce představím koncept této teorie a nahlédneme na ní z pohledu moderní kvantové chromodynamiky.

STAR - Heavy Flavour / 45

## $\Lambda_c$ baryon reconstruction and measurement of the $\bar{\Lambda}_c^- / \Lambda_c^+$ at the STAR detector in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV

**Author:** Miroslav Šimko<sup>1</sup>

<sup>1</sup> CTU FNSPE

**Corresponding Author:** miroslav.simko@jfifi.cvut.cz

$\Lambda_c$  is the lightest baryon containing a charm quark and, as such, presents a unique probe into the behavior of heavy quarks in the hot and dense QCD medium. Together with the measurement of the  $D^0$  meson, we can probe the various modes of hadronization of the charm quark in heavy-ion collisions and bring more insight into the possible process of quark coalescence in the strongly coupled quark-gluon plasma. The yield ratios of strange anti-baryons to baryons have been measured in heavy-ion collisions and exhibit a trend that is closer to unity with increasing number of valence strange quarks. This ratio has, however, never been measured for charm baryons, and it will be important to establish if they exhibit a similar amount of baryon-to-anti-baryon enhancement as strange baryons. However,  $\Lambda_c$  baryons have an extremely small lifetime ( $c\tau \sim 60 \mu\text{m}$ ) and have not been measured in heavy-ion collisions yet. The newly installed STAR Heavy Flavor Tracker (HFT) has shown high efficiency and a before unforseen pointing resolution that can facilitate the reconstruction of hadronic decays in heavy-ion collisions. In run 2014, STAR has collected 1.2 B events of minimum bias Au+Au collisions  $\sqrt{s_{NN}} = 200$  GeV. In this talk, I will show the first measurement of the  $\Lambda_c$  in high-energy heavy-ion collisions. I will report reconstruction of  $\Lambda_c$  baryons via hadronic decays, using 2014 Au+Au data at  $\sqrt{s_{NN}} = 200$  GeV at STAR. Moreover, I will present first, preliminary, measurement of the  $\bar{\Lambda}_c^- / \Lambda_c^+$  ratio from the same data set.

46

## Propagace a WWW

**Authors:** David Horák<sup>1</sup>; Radek Novotný<sup>2</sup>

<sup>1</sup> *České vysoké učení technické v Praze*

<sup>2</sup> *CTU FNSPE*

**Corresponding Authors:** david.horak@fjfi.cvut.cz, radek.novotny2@fjfi.cvut.cz

Studium jetů / 47

## Measurement of inclusive $p_T$ spectra of jets in pp collisions at the ALICE experiment

**Author:** Peter Pribeli<sup>1</sup>

<sup>1</sup> *FJFI*

**Corresponding Author:** peter.pribeli@cern.ch

The aim of this work is to explore the properties of hard processes in QCD which occur during high energy pp collisions. Subsequently the analysis of the ALICE data of inclusive charged jet  $p_T$  spectra is presented. The correction of the data on various detector effects is realized. Finally, systematic uncertainties are estimated and the results compared with the Monte Carlo generator PYTHIA.

STAR - Heavy Flavour / 48

## The effects of QGP and CNM on heavy quarkonia production

**Author:** Oliver Matonoha<sup>1</sup>

<sup>1</sup> *CTU FNSPE*

**Corresponding Author:** matonoli@fjfi.cvut.cz

In this presentation, we will give an introduction to the physics of heavy quarkonia in ultra-relativistic collisions of heavy nuclei. Different production-affecting phenomena will be overviewed and juxtaposed with experimental results of related observables. Furthermore, we will present recent measurements of the  $\Upsilon$  production in Au+Au collisions at  $\sqrt{s_{NN}} = 200$ -GeV via the di-lepton channel by the STAR experiment at RHIC. At RHIC energies, the regeneration and some of the CNM effects are expected to have little or no effect for the bottomonium family, which makes it one of the cleanest probes of the screening effect.

49

## Rydberg atoms in electric fields

**Author:** Hana Hruběšová<sup>1</sup>

<sup>1</sup> *CTU FNSPE*

**Corresponding Author:** hrubehan@fjfi.cvut.cz

Significant amount of antimatter studies has been build on making a comparison between the (physical) properties of particle and antiparticle. As a natural candidate for testing this symmetry is a hydrogen-antihydrogen system. Because of long studied and a well-known hydrogen atom, the antihydrogen is an ideal candidate for experimental studying of antimatter. To perform the same precision measurement at antihydrogen is necessary to have antiatoms in isolated and at calm state. These conditions help to minimize disturbance to the system and allow the length of measurements needed for precision results. The process of forming antihydrogen atoms is called resonant charged exchange reaction  $Ps^* + \bar{p} \rightarrow \bar{H}^* + e^-$ . In this exchange is  $Ps^*$  excited to high Rydberg state. Rydberg atoms, atoms in which the valence electron is in a state of high principal quantum number  $n$ . The newly produced antihydrogen kept the principal quantum number  $n$  of Positronium. For further using of antihydrogen in the experiment is needed to explore the behaviour of Rydberg atoms in the external electric field. Specially focused on the trapping of Rydberg atom and manipulation using electric fields.

50

## Kde hledat příznaky nové fyziky, když je nevidí LHC?

**Corresponding Author:** vladimir.wagner@fjfi.cvut.cz

51

## Zahájení

RQGP / 52

## How do quarks and gluons lose energy in the QGP?

**Author:** Zuzana Moravcová<sup>1</sup>

<sup>1</sup> CTU FNSPE

**Corresponding Author:** zuzana.moravcova@fjfi.cvut.cz